

Joint Theater Trauma System Clinical Practice Guideline

Neurosurgical Management Guidelines

Original Release/Approval	6 Mar 2012	Note: This CPG requires an annual review.	
Reviewed:	Jan 2012	Approved:	6 Mar 2012
Supersedes:	This is a new CPG and must be reviewed in its entirety.		
<input type="checkbox"/> Minor Changes (or)	<input type="checkbox"/> Changes are substantial and require a thorough reading of this CPG (or)		
<input type="checkbox"/> Significant Changes			

1. **Goal.** To provide guidance to deploying neurosurgeons on combat neurosurgical care. This CPG is in addition to [Management of Patients with Severe Head Trauma](#) and [Catastrophic Care](#) CPGs which trend towards medical management.

2. **Background.**

A significant portion of combat-related TBI patients requiring inpatient care have sustained brain injuries that are moderate to severe in nature. The most frequent mechanisms of injury encountered in theaters of armed conflict are distinctly different from those most commonly encountered in civilian trauma centers. The treatment of combat-related TBI continues to evolve, with improved understanding of the role of cranial decompression in improving outcome of penetrating injuries and following explosion-related TBI. With appropriate utilization of neurosurgical interventions both short and long term outcomes of combat-related TBI can be optimized, with the VA rehabilitation experience demonstrating that even patients experiencing coma after combat related TBI may improve to emerge from these states in up to 66% of patients with severe TBI.

- a. Penetrating intracranial injury

The high velocity kinetics exerted by the type of firearms and explosives commonly encountered in combat operations may exert significantly greater injury upon brain tissue than low-velocity counterparts. Although brain debridement alone has been advocated for these injuries in the past, recent reported experience with these injuries in OIF / OEF has suggested that improved survival is associated with the more aggressive utilization of formal decompressive procedures. Penetration of foreign bodies due to explosive events may be highly variable in their kinetic properties and the amount of brain injury that results. Experience in OIF / OEF has demonstrated however, that these patients are prone to cerebral vasospasm and will have improved outcome when provided decompression. Among patients who do not have existing or impending signs of brain death on arrival, strong consideration should be given to the use of craniectomy.

- b. Blunt intracranial injury

Pure blunt mechanisms of injury are less common following combat and are most commonly associated with the sequela of explosive events. The surgical indications for blunt mechanisms, however, more closely parallel those of civilian experience. Evidence of mass lesion requiring evacuation must be rapidly identified and treated surgically.

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c. Surgical management

1) Debridement

Appropriate debridement of devitalized brain tissue should be undertaken following penetrating injuries.

2) Hemorrhage control

- a) Appropriate resuscitative strategies using the principles outlined in the Damage Control Resuscitation CPG should be adhered to, including the appropriate utilization of blood product ratios.
- b) Surgical hemostatic techniques commonly employed in the care of civilian TBI should be meticulously employed.
- c) The use of novel topical hemostatics, including thrombin soaked gel-foam and FloSeal hemostatic matrix and can be considered to assist in control of hemorrhage not amenable to traditional techniques in the setting of damage control.

3) Foreign removal

The routine pursuit of individual foreign bodies within the brain is not advisable, but should be left to the discretion of the neurosurgeon. Anatomy and the findings within the surgical field at the time of operation should be considered on an individualized basis to guide decisions regarding removal of these projectiles.

4) Decompression

- a) Surgical decompression should be strongly considered following high velocity penetration, as the kinematics of these injuries in the combat setting may be considerably different from gunshot injuries encountered in civilian trauma. For this reason, and due to the concerns associated with early CCATT transport for many of these patients, more liberal utilization of craniectomy is likely to be required
- b) Decompression should be undertaken for all salvageable patients with mass lesions requiring evacuation following low-velocity and blunt mechanisms of injury.

5) Dural closure

Duroplasty, or primary dural closure should be considered with caution due to the ongoing edema that may follow explosive and high-energy penetrating injuries. Dural substitutes should, likewise be employed with careful consideration for the ongoing evolution of injury.

6) Flap management

- a) US and Coalition: DO NOT save or send the calvarium with the patient for later re-implantation. The removed calvarium, may, however, be sent back to CONUS separately for US casualties in order to assist in the creation of a prosthetic. More commonly, early export of CT images that can be utilized to begin the modeling process are utilized. Reconstruction will be accomplished out of theater using alloplastic reconstruction techniques for all US and coalition casualties.

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b) Local nationals - options include:

- Wash and store at local facility in freezer at -70
- Wash and replace
- Wash and store in abdominal flap

7) Drainage: JP Drainage and management

JP drainage may be advisable in appropriately selected patients. It is not advisable to discontinue a post-operative drain in the immediate period prior to aeromedical evacuation.

8) ICP monitoring; Options include:

- a) Ventriculostomy
- b) Intracranial Bolt (Codman)
- c) Special considerations for combat-related injuries exposed to aeromedical evacuation are covered below in item (d).

9) Antibiotic management

At a minimum, cefazolin should be continued for 5 days for all penetrating head injured patients. Brain Injury guidelines from the civilian literature advise, under option level recommendations, that broad spectrum antibiotics be utilized. Early experiences in OIF / OEF were noted to have appreciable rates of MDR organisms complicating craniectomy; most notably *Acinetobacter* requiring meropenem. The exact course of prophylaxis is unknown, but available literature suggests that 5 to 7 days should be utilized routinely. Decisions regarding antibiotic choice and duration of prophylaxis can be made in coordination with the acting Infectious Disease consultant at your facility, at the Role IV at LRMC, or via the JTTS consultation program.

d. Aeromedical evacuation considerations:

- 1) Observation in theater or further decompression is necessary for patients with marginal ICP measurements due to stresses of flight including: vibration, temperature, noise, movement, light, hypoxia of altitude.
- 2) ICP monitoring is advised for any patient who:
 - a) Cannot be awoken hourly for neurologic evaluation / checks
 - b) Have ongoing resuscitative requirements and an intracranial lesion or the potential for development of cerebral edema. This is particularly the case for patients with significant burns requiring resuscitation by the burn CPG, who should routinely undergo ICP monitoring in the setting of intracranial mass lesion or evidence of intracranial edema.
- 3) Pneumocephalus

The effects of altitude on contained air within the body, including the cranium, will potentially result in expansion of pneumocephalus. This factor should be considered carefully by the treating neurosurgeon and coordination with CCATT undertaken to discuss

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the potential risk for each transport with pneumocephalus; particularly those who have not undergone decompression prior to flight.

4) Hyperthermia prevention

NNMC data suggests that temperatures above 99 degrees may increase the patients' risk for vasospasm. For this reason, hyperthermia should be avoided during transport

5) High risk environment for venous thrombosis.

All patients without evidence of ongoing hemorrhage require routine DVT prophylaxis

a) Begin prophylaxis in all patients on POD #1 with enoxaparin 30mg sq bid UNLESS:

- Hemorrhagic complication (increased blood seen on follow-up CT scan)
- Prohibitive contraindication for bleeding risk (high-grade liver injury with ongoing coagulopathy)
- Hold 24-36 hours before planned re-operation

b) Subcutaneous heparin can also be utilized with the same practice caveats as listed above.

6) All patients should be transported/managed with maximum head elevation 30-45 degrees unless an unstable T12-L5 fracture is present. For those patients requiring spine immobility, reverse trendelenberg position should be considered whenever possible.

3. Performance Improvement Monitoring.

a. Intent (Expected Outcomes).

- 1) Liberal use of decompressive craniectomy is employed in patients suffering high velocity head wounds and in patients with low velocity wounds or blunt trauma with an associated space occupying lesion.
- 2) Antibiotic prophylaxis is utilized in all patients with penetrating head injuries.
- 3) ICP or like monitoring is utilized in all patients who cannot undergo adequate neurologic and mental status evaluation on an hourly basis during transport out of theater.

b. Performance/Adherence Measures.

- 1) Surgical decompression was undertaken by a neurosurgeon in salvageable patients when the mechanism of injury (MOI) was high velocity GSW or fragment wound or when there was a space occupying lesion in association with a low velocity or blunt MOI.
- 2) The excised calvarium was not re-implanted into a US or coalition patient following craniectomy.
- 3) Antibiotics were given to all patients with penetrating head injuries.
- 4) ICP monitor or ventriculostomy was placed in all patients with severe TBI unable to be awoken on an hourly basis during transport.

c. Data Source.

- 1) Patient Record

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2) Joint Theater Trauma Registry (JTTR)

- d. **System Reporting & Frequency.** The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Trauma System (JTS) Director, JTS Deputy Director/Program Manager, and JTS Performance Improvement Branch.

4. **Responsibilities.** It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

5. References.

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3. Armonda RA, Bell RS, Vo AH, Ling G, DeGraba TJ, Crandall B, Ecklund J, Campbell WW. Wartime traumatic cerebral vasospasm: recent review of combat casualties.
4. DuBose JJ, Bamparas G, Inaba K, Stein DM, Scalea T, Cancio LC, Cole J, Eastridge B, Blackbourne L. Isolated severe traumatic brain injuries sustained during combat operations: demographics, mortality outcomes, and lessons to be learned from contrasts to civilian counterparts. *J Trauma*. 2011 Jan;70(1):11-6; discussion 16-8.
5. Latronico N, Berardino M. Thromboembolic prophylaxis in head trauma and multiple-trauma patients. *Minerva Anestesiol* 2008 Oct; 74(10):543-8.

Approved by CENTCOM JTTS Director,
JTS Director and CENTCOM SG

Opinions, interpretations, conclusions, and recommendations are those of the authors and are not necessarily endorsed by the Services or DoD.

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APPENDIX A

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGs

1. Purpose.

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of “off-label” uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

2. Background.

Unapproved (i.e., “off-label”) uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing “investigational new drugs.” These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

3. Additional Information Regarding Off-Label Uses in CPGs.

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the “standard of care.” Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

4. Additional Procedures.

- a. Balanced Discussion. Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.
- b. Quality Assurance Monitoring. With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.
- c. Information to Patients. Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.